Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia - Social and Behavioral Sciences 61 (2012) 212 – 213

Procedia
Social and Behavioral Sciences

Academy of Aphasia 2012

Neural Representation of Grammatical Categories: An ALE Meta-analysis

Sebastian R.[a,*], Faroqi-Shah Y.[b]

[a] *Calvert Memorial Hospital, Maryland*
[b] *University of Maryland, College Park, USA*

Introduction

There are numerous conceptual, semantic and morphosyntactic differences between nouns and verbs, leading to the hypothesis that these two grammatical categories may be neuroantomically segregated in the brain (Damasio & Tranel, 1993). However, functional neuroimaging and lesion findings have been mixed, and there is little current consensus as to whether nouns and verbs are functionally and neuroanatomically modular (Crepaldi et al., 2011). Given that functional neuroimaging findings may be discrepant due to differences in methodology, analyses procedures, scanner types, and participant characteristics across studies, it is imperative to identify brain regions that are consistently activated despite methodological differences.

The primary objective of this study was to objectively examine neural correlates of verb and noun processing by conducting an activated likelihood estimation (ALE) of published functional neuroimaging data. ALE is a statistical technique which extracts voxels that are consistently activated across studies by modeling activation foci reported by each study as a probability distribution (Laird et al., 2005).

Methods

A literature search (PubMed) on neuroimaging studies of verb and noun processing that reported activation coordinates identified seventeen eligible studies. Two main levels of analysis were conducted using ALE implemented in BrainMap (Laird et al., 2005; http://www.brainmap.org/ale): 1) simple effects examining neural activity for a category relative to a baseline contrast (Verbs minus baseline, Nouns minus baseline); and 2) direct comparisons between grammatical categories (Verbs minus nouns, Nouns minus Verbs).

Results & Discussion

ALE analysis identified a distributed network of brain regions primarily in the left hemisphere (Figure 1). In the simple effects analysis, both noun and verb processing activations were largest in the left frontal lobe (BA 44, 45,46), followed by temporoparietal clusters (BA 37,40 for nouns; BA 20,21 for verbs). The direct verbs-minus-nouns contrast identified predominantly left superior/middle temporal (BA 21,22) followed by inferior/middle frontal activations (BA 4, 44, 45, 46). The nouns-minus-verbs comparison revealed generally smaller clusters, which were bilateral in the cingulate and supramarginal gyri, and left middle frontal gyrus. A caveat of this last contrast was a low number of activation of foci included in the analysis. Larger activation clusters were found for verbs relative to nouns (left frontal & superior temporal). To summarize, these results are inconsistent with a frontal-temporal dichotomy for verbs versus nouns (Damasio & Tranel, 1993) and suggest significant overlapping left frontal

* Corresponding author. Tel.: 301-405-4229 .
E-mail address: yfshah@umd.edu .

1877-0428 © 2012 Published by Elsevier Ltd. Selection and/or peer-review under responsibility of The Academy of Aphasia
Open access under CC BY-NC-ND license. doi:10.1016/j.sbspro.2012.10.153

involvement for both word classes, and differential involvement of cingulate and left posterior temporo-parietal regions.

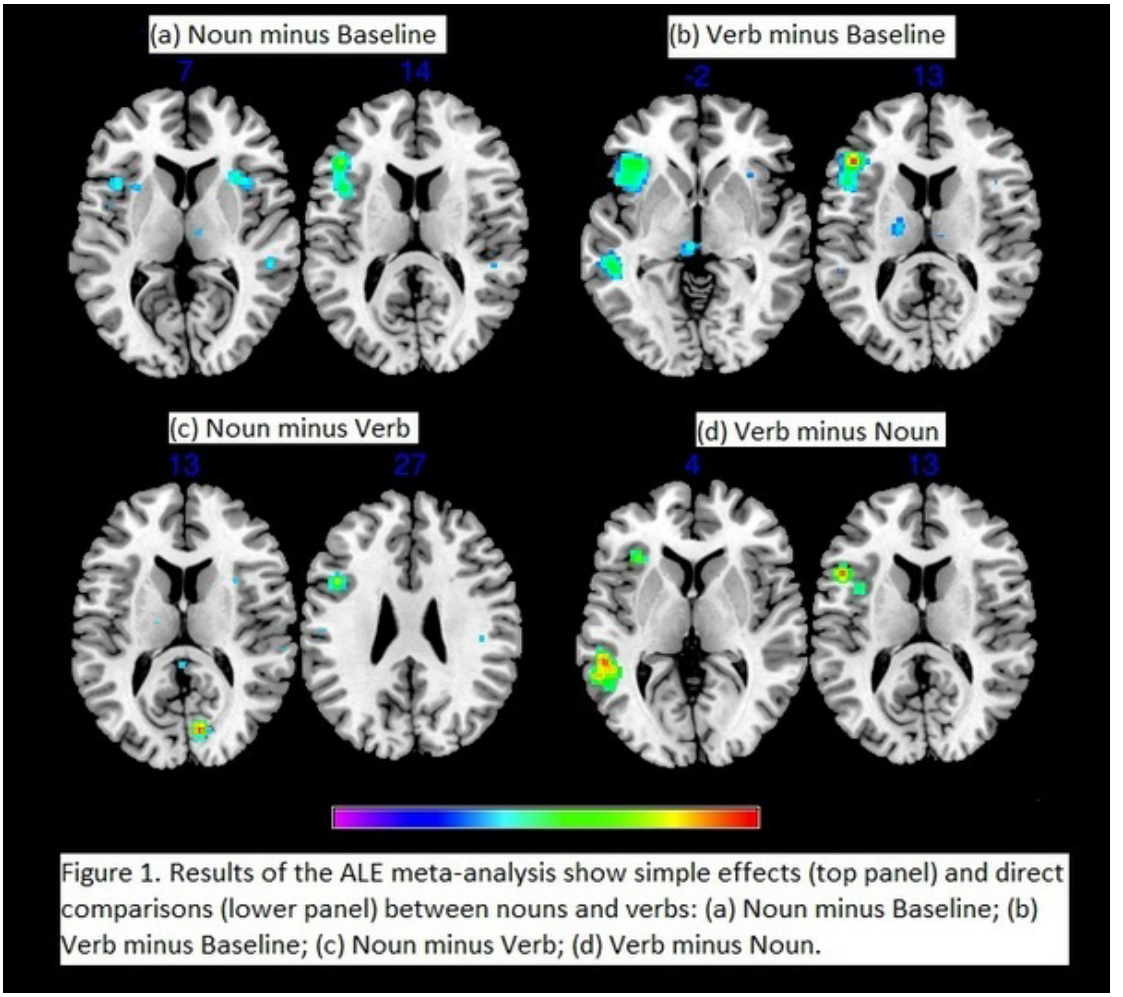

Figure 1. Results of the ALE meta-analysis show simple effects (top panel) and direct comparisons (lower panel) between nouns and verbs: (a) Noun minus Baseline; (b) Verb minus Baseline; (c) Noun minus Verb; (d) Verb minus Noun.

References

Crepaldi, D., Berlingeri, M., Paulesu, E., & Luzzatti, C. (2011). A place for nouns and a place for verbs? A critical review of neurocognitive data on grammatical-class effects. *Brain and Language, 116,* 33-49.

Damasio, A. R., & Tranel, D. (1993). Nouns and verbs are retrieved with differently distributed neural systems. *PNAS U S A, 90,* 4957-4960.

Laird, A. R., McMillan, K. M., Lancaster, J. L., Kochunov, P., Turkeltaub, P. E., Pardo, J. V., & Fox, P. T. (2005). A comparison of label-based review and ALE meta-analysis in the Stroop task. *Human Brain Mapping, 25,* 6–21.